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DETERMINING THE OPTIMUM TIMING FOR THE FINAL IRRIGATION ON MID-SOUTH COTTON

Earl Vories
University of Arkansas
Keiser, AR
Tina Teague
University of Arkansas
State University, AR
Jeremy Greene
University of Arkansas
Monticello, AR
William Robertson and Phil Tacker
University of Arkansas
Little Rock, AR
Jason Stewart
Arkansas State University
State University, AR
Bobby Phipps
University of Missouri
Portageville, MO
Joel Faircloth
Louisiana State University
Winnsboro, LA
Ernie Clawson
Louisiana State University
St. Joseph, LA

Abstract

US Cotton growers are adopting COTMAN, a COTton MANagement system developed at the University of Arkansas and used to monitor crop development and aid in making end-of-season decisions. Currently, research-based decision guides have been developed to aid in identifying the last effective boll population and determining dates for safe termination of insect control and the application of defoliants based on physiological cutout, or NAWF=5. An area of cotton production that may benefit from COTMAN is the decision of when to stop irrigating the crop. The objective of this research was to investigate a crop-based recommendation for timing the final irrigation on cotton. Ten irrigation studies were conducted in four states (Missouri, Arkansas, Louisiana and Texas) during the 2003 growing season to investigate the response to late-season irrigation. Irrigation treatments consisted of different irrigation termination times at each site, with the first termination treatment targeted for approximately NAWF=5. The Texas studies dealt with drip and LEPA irrigation and are reported elsewhere. The study in Portageville, Missouri could not be completed due to late-season rains and herbicide drift seriously damaged the study at St. Joseph, Louisiana. In addition, data from one of the Arkansas studies were not available at the time of this writing. Only one of the five other mid-South studies showed significant differences in cotton yield with later irrigation. In the case where yield differences were significant in southeast Arkansas, yield tended to increase throughout the study period. No differences in fiber quality were observed; however, the samples were from studies where yield was not significantly affected. Additional studies will be required to develop a reliable recommendation for timing the final irrigation.

Introduction

Cotton growers across the Cotton Belt are adopting COTMAN, a COTton MANagement system developed at the University of Arkansas and used to monitor crop development and aid in making end-of-season decisions (Danforth and O'Leary, 1998). The later-season portion of the system is based on monitoring the number of nodes above the uppermost first-position white flower (NAWF) on a plant. Research has shown that as the developing bolls require more of the plant resources, the development of new nodes slows and the first-position white flower "moves" progressively toward the plant apex. Bourland et al. (1992) found that a first-position white flower five nodes below the plant terminal represented the last effective flower population. Their work indicated that flowers set after NAWF=5 have a higher shed rate and lower mass, resulting in only a minor contribution to final yield. Based on their findings, NAWF=5 is generally accepted as physiological cutout.

The COTMAN system uses a target development curve (TDC) as a reference to compare with actual crop development. The TDC has flowering beginning at 60 days after planting (DAP) and NAWF=5 at 80 DAP. Comparisons of actual crop devel-

opment to the TDC provide an indication of the maturity of the crop. Early-season stress often results in first flower at a relatively low NAWF value and physiological cutout occurring in less than 80 DAP.

Currently, research-based decision guides have been developed to aid in identifying the last effective boll population and determining dates for safe termination of insect control and the application of defoliants based on physiological cutout, or NAWF=5. Research projects underway in several cotton-producing states are focused on other ways to use the information from COTMAN to aid in management decisions regarding the crop (e.g., growth regulator applications). One area of cotton production that may benefit from COTMAN is the decision of when to stop irrigating the crop. Recommendations in Arkansas and other states concerning the timing of the final irrigation are often based on the appearance of the first open boll. Such recommendations ignore the maturity of later-maturing bolls and often reflect as much fear of promoting boll rot as providing for the water needs of the maturing bolls. A recommendation that relates the timing of the final irrigation to physiological cutout should better fit the needs of the crop and follows the approach taken with other management recommendations. Vories et al. (2001) reported on a study at three northeast Arkansas locations in 2000; Vories et al. (2002) reported on another eight mid-South studies in 2001; and Vories et al. (2003) reported on another ten mid-South studies in 2002. However, with the impact of late-season rain in many cases, additional studies are still needed to develop a meaningful recommendation.

Objective

The objective of this research was to investigate a crop-based recommendation for timing the final irrigation on cotton.

Materials and Methods

Ten irrigation termination studies were conducted in four states (Missouri, Arkansas, Louisiana and Texas) during the 2003 growing season. For each study, NAWF data were collected weekly from early flower until NAWF<5. With the exception of irrigation termination, cultural practices followed Cooperative Extension Service (CES) recommendations for the area. Information about the crops in each of the mid-South studies is included in Table 1. For each site, the first termination treatment was targeted for approximately NAWF=5 (physiological cutout). An additional treatment was terminated with each subsequent irrigation. Fiber samples were submitted to Cotton Incorporated for high volume instrument (HVI) analyses but not all of the results were available at the time of this report. Fisher's protected least significant difference (LSD) was used to compare treatment means for significant ($p \leq 0.05$) effects. Unless otherwise noted, cotton was planted on 38-inch rows and furrow irrigated. An assumed gin turnout of 35% was used to calculate lint yield at each location. Additional irrigation termination studies in Texas using drip (Multer et al., 2004) and LEPA (Doederlein et al., 2004) irrigation were reported separately.

Southeast Missouri

A study with four replications was conducted at the Lee Farm of the University of Missouri Delta Experiment Station at Portageville. The soil was Tiptonville silt loam and the whole field was furrow irrigated until late in the season when the irrigation termination treatments were to be applied. At the end of the season, sprinkler irrigation was to be used to manage the treatments. Irrigation plots were to be 8 rows approximately 37 ft long. Two rows from the center of each plot were to be harvested for yield determination. However, excessive late-season rainfall caused the treatments not to be applied.

Northeast Arkansas

Two studies were conducted in Mississippi County and one in Craighead County in northeast Arkansas. One study with four replications was on the University of Arkansas Northeast Research and Extension Center (NEREC) at Keiser, on a field containing areas of Sharkey silty clay and Sharkey-Steele complex soils. Irrigation plots were four rows approximately 800 ft long, with four buffer rows between plots. Seedcotton weights were obtained from all four rows of each plot using an instrumented boll buggy. A second study with four replications was on Field 89 of Wildy Farms near Manila, with areas of Routon-Dundee-Crevasse complex and Amagon sandy loam soils. Irrigation plots were 18 rows approximately 1200 ft long. Seedcotton weights were determined from the center 12 rows of each plot using a yield monitor, and results from Wildy 89 were not available at the time of this report. A third study with four replications was conducted on the Peel Farm near Monette (Craighead County), with a combination of Dundee-Bruno-Commerce complex, Beulah fine sandy loam, and Commerce very fine sandy loam soils. Irrigation plots were 24 rows approximately 1200 ft long. Seedcotton weights were determined from the center 12 rows of each plot using an instrumented boll buggy.

Central-East Arkansas

One study was conducted in Lee County in central-east Arkansas on the Cotton Branch Experiment Station (CBS) near Mariana. The experiment with three replications was on a Memphis silt loam. Irrigation plots were 4 rows approximately 800 ft long, with 4 buffer rows between plots. Seedcotton weights were determined from all 4 rows of each plot using an instrumented boll buggy.

Southeast Arkansas

Two studies were conducted in Desha County in southeast Arkansas on the Steve Stevens Farm near Rohwer. One experiment with four replications was on the S Wayne field on a Rilla silt loam. Irrigation plots were 16 rows approximately 1200

ft long. Seedcotton weights were determined from 4 rows near the center of each plot for one harvest using an instrumented boll buggy. The second experiment with four replications was on Barrett field on a Rilla silt loam. Irrigation plots were 16 rows approximately 500 ft long. Seedcotton weights were determined from 4 rows near the center of each plot using an instrumented boll buggy.

Northeast Louisiana
An irrigation termination experiment was conducted in Tensas Parish at the Louisiana State University Northeast Research Station (NRS) near St. Joseph. Herbicide drift seriously affected much of the test and the study could not be completed.

Results and Discussion

Southeast Missouri
The cotton crop did not reach NAWF=5 before the COTMAN last possible cutout date at 15% risk level for Portageville, MO of July 31 (69 DAP). Frequent rains eliminated the need for late-season irrigation and the study was not completed.

Northeast Arkansas
The NEREC field and Wildy 89 reached NAWF=5 on 78 DAP (July 17 for NEREC and August 1 for Wildy 89), only 2 days earlier than the 80 DAP for the COTMAN TDC (Table 1). However, the crop at NEREC was stressed from cool, wet conditions early in the season and there were no observations of NAWF>6. The Peel field reached NAWF=5 on August 15 (77 DAP). The same cool, wet early-season conditions mentioned previously caused the field to be replanted on May 30. Therefore, the NAWF=5 date was five days later than the COTMAN latest possible cutout date at 50% risk level for the area. Both the NEREC and Peel sites had large rainfalls treated as an "effective" irrigation for the earliest treatment (Table 2). Final irrigation treatments at NEREC ranged from 14 days (299 DD60) after NAWF=5 to 36 days (753 DD60) after NAWF=5. Treatments at Peel were earlier, relative to NAWF=5, ranging from 11 days (174 DD60) before NAWF=5 to 12 days (297 DD60) after NAWF=5. Yield differences were not significant at either site (Table 3). Similarly, fiber analysis from the NEREC study showed no significant differences (Table 4). Yield data from Wildy 89 were not yet analyzed at the time of this writing.

Central-East Arkansas
The CBS field reached NAWF=5 on August 1 (83 DAP), only 3 days later than the 80 DAP for the COTMAN TDC (Table 1). Final irrigation treatments ranged from 14 days (274 DD60) before NAWF=5 to 49 days (851 DD60) after NAWF=5 (Table 2). There was quite a lot of rainfall during the treatment period, and the August 27 treatment was irrigation on the 26th followed by a 0.75-inch rainfall. No significant yield differences were observed (Table 3), nor were any differences in fiber quality (Table 4).

Southeast Arkansas
Both fields reached NAWF=5 only on 86 DAP (July 26 for Stevens S Wayne and July 24 for Stevens Barrett; Table 1). Final irrigation treatments at S Wayne ranged from 17 days (445 DD60) after NAWF=5 to 32 days (864 DD60) after NAWF=5 (Table 2). Two of the treatments were followed immediately by rain, so the treatment date was delayed one day. Final irrigation treatments at Barrett ranged from 19 days (424 DD60) after NAWF=5 to 34 days (906 DD60) after NAWF=5 (Table 2). The Barrett field also had an irrigation followed by a rain (August 20 treatment). While no significant yield differences were observed at Barrett, the differences were significant at S Wayne, where yield tended to increase with later irrigation (Table 3) throughout the study period. The final irrigation was at 864 DD60 after NAWF=5, while 850 DD60 after NAWF=5 has generally proven to be harvest ready.

Northeast Louisiana
Based on limited observations, the NRS field reached NAWF=5 on about July 20 (89 DAP), about 9 days later than the 80 DAP for the COTMAN TDC (Table 1). However, as previously stated, herbicide drift seriously affected much of the test and the study could not be completed.

Conclusions

Rainfall interrupted the study in southeast Missouri and also affected other studies. Of the six mid-South studies that were completed, only one showed significant differences in cotton yield with later irrigation, although the data from Wildy 89 have not yet been analyzed. In the case where yield differences were significant in southeast Arkansas (Stevens S Wayne), yield tended to increase throughout the study period. The final irrigation was at 864 DD60 after NAWF=5, while 850 DD60 after NAWF=5 has generally proven to be harvest ready. No differences in fiber quality were observed; however, the samples were from studies where yield was not significantly affected.

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Table 1. Cultivar and significant dates for each site from the 2003 cotton irrigation termination studies.

		Planting	NAWF=5		
Location	**Cultivar**	**Date**	**Date**	**DAP**	**Harvest**
Lee Farm	PM 1218 BG/RR	16 May	31 Jul*	76	--
NEREC	SG 105	30 Apr	17 Jul	78	30 Sep
Wildy 89	SG 215 BG/RR	15 May	1 Aug	78	8 Nov
Peel	DP 451 BG/RR	30 May	15 Aug**	77	30 Oct
CBS	PM 1218 BG/RR	10 May	1 Aug	83	17 Oct
Stevens S Wayne	ST 5599 BR	1 May	26 Jul	86	8 Oct
Stevens Barrett	DP 451 B/RR	29 Apr	24 Jul	86	29 Sep
NRS	ST 5599 BR	22 Apr	~20 Jul	89	--

* COTMAN latest possible cutout date for Portageville, MO at 15% risk level

** later than the COTMAN latest possible cutout date for Monette, AR at 50% risk level (August 10)

Table 2. Timing of the final irrigation in the 2003 cotton irrigation termination studies.

	Final Irrigation			
Treatment	Date	Days after planting	Days after* NAWF=5	DD60 after* NAWF=5
		NEREC		
1	31 Jul**	92	14	299
2	11 Aug	103	25	505
3	22 Aug	114	36	753
		Peel		
1	4 Aug**	66	-11	-174
2	14 Aug	76	-1	-19
3	27 Aug	89	12	297
		CBS		
1	18 Jul	69	-14	-274
2	11 Aug	93	10	195
3	19 Aug	101	18	356
4	27 Aug***	109	26	536
5	12 Sep	125	42	782
6	19 Sep	132	49	851
		Stevens S Wayne		
1	12 Aug***	103	17	445
2	20 Aug***	111	25	658
3	27 Aug	118	32	864
		Stevens Barrett		
1	8 Aug	116	19	424
2	14 Aug	123	26	568
3	20 Aug***	113	27	699
4	22 Aug	115	29	760
5	27 Aug	120	34	906

* negative values signify that the final irrigation was made before a field-average NAWF=5

** date represents last of several days with rain, used as “effective” irrigation date

*** date changed by one day to account for rain on day following irrigation

Table 3. Lint yield, assuming 35% gin turnout, from the 2003 cotton irrigation termination studies.

Treatment	Lint Yield, lb/acre
NEREC	
1	636
2	670
3	651
$LSD_{(0.05)}$	n.s.
Peel	
1	730
2	721
3	746
$LSD_{(0.05)}$	n.s.
CBS	
1	690
2	654
3	657
4	692
5	632
6	631
$LSD_{(0.05)}$	n.s.
Stevens S Wayne	
1	1069
2	1184
3	1276
$LSD_{(0.05)}$	117
Stevens Barrett	
1	1109
2	1146
3	1168
4	1181
5	1149
$LSD_{(0.05)}$	n.s.

Table 4. Fiber quality from the 2003 cotton irrigation termination studies.

Treatment	micronaire	length (in)	strength (g/tex)
NEREC			
1	4.62	1.145	30.1
2	4.70	1.150	30.6
3	4.88	1.142	30.5
$LSD_{(0.05)}$	n.s.	n.s.	n.s.
CBS			
1	5.77	1.077	28.6
2	5.43	1.050	28.7
3	5.63	1.100	30.3
4	5.73	1.073	28.8
5	5.70	1.077	29.6
6	5.73	1.077	31.2
$LSD_{(0.05)}$	n.s.	n.s.	n.s.